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Best Current Practices for Digital Sovereignty and Meaningful Connectivity through Circular Management of User and Network Devices
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Abstract

This document describes Best Current Practices (BCP) for improving meaningful connectivity and digital sovereignty through the circular management of end-user and network devices. It addresses a foundational but often overlooked dependency of Internet access deployments: the availability, repairability, governance, and lifecycle management of devices required to meaningfully use access networks.

Based on operational experience from deployments in Spain, Argentina, and Senegal宴琶ncluding eReuse.org, EKOA/UNLP, Solidanテァa, TAU/RAEE, and Hahatay宴杯his document identifies practices that have demonstrated positive access, social, and environmental outcomes. These practices complement research within the IRTF GAIA Research Group by documenting reproducible operational approaches that increase the sustainability, autonomy, and long-term viability of Internet access in underserved contexts, and therefore contribute to facilitate "the unconnected" to connect.

Status of This Memo

This Internet-Draft is submitted in full conformance with the provisions of BCP 78 and BCP 79.

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1. Introduction

Extending Internet access requires more than deploying network infrastructure and connectivity. Meaningful connectivity depends on the availability of functional, affordable, and maintainable end-user devices (e.g., laptops, phones) and, in many deployments, network devices (e.g., routers, switches, antennas). In underserved communities, the absence of such devices is often a primary barrier to benefiting from existing or planned access networks.

Circular device management寰覇ncompassing local reuse, repair, refurbishment, redistribution, and responsible end-of-life handling寰派as emerged as an effective approach to address this barrier. When combined with community-centred governance and digital traceability, these practices can improve access outcomes, strengthen local capacity, and reduce environmental impact.

This document draws on operational experience from:

* eReuse.org deployments in Catalonia and Madrid (Spain), involving social enterprises and reuse circuits that coordinate donors, refurbishers, and recipient organisations;

* University-linked programmes in Argentina (EKOA/UNLP), integrating refurbishment, training, and community engagement;

* TAU/RAEE in Rosario (Argentina), where a specialised cooperative carries out device diagnostics, repair, data sanitization, refurbishment, and e-waste management, while community centres focus on access, accompaniment, and territorial programmes;

* Hahatay initiative in Senegal, combining device availability with local digital inclusion efforts in rural and peri-urban contexts.

Several of these initiatives apply collective access and community-ownership models in which devices are managed as shared resources, a commons [Ostrom1990], rather than permanently transferred private property. Digital lifecycle tracking supports transparency, accountability, and coordinated management across donors, refurbishers, and communities. This approach has been formalised and analysed in prior research [Roura2025].

This BCP adopts a community-centred interpretation of meaningful connectivity, consistent with civil-society analyses [GISW2024], in which connectivity gains value when aligned with local needs, governance, skills, and social relevance.

1.1. Relevance to IRTF GAIA

The IRTF GAIA Research Group investigates technical and socio-technical approaches to extend Internet access to underserved populations. Device availability, repairability, and lifecycle governance form a foundational layer of access architectures and affect sustainability, resilience, autonomy, and adoption.

This document does not specify Internet protocols. Instead, it documents deployment and operational practices that have demonstrated effectiveness in real-world access contexts and may inform future GAIA research, architecture discussions, and deployment models.

2. Terminology and Scope

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "NOT RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in BCP 14 ([RFC2119]) ([RFC8174]) when, and only when, they appear in all capitals, as shown here.

Circular device management: Structured processes that enable reuse, repair, refurbishment, redistribution, tracking, and responsible recycling of devices.

Collective access/community ownership: A governance model in which devices are managed as shared resources, with rights of use, maintenance, and reassignment defined collectively rather than through permanent individual ownership, following a common-pool resource governance model. [Ostrom1990]

Community-centred infrastructure: Digital infrastructure (devices, facilities, local organisations, and governance) that is locally operated and aligned with community needs.

Commodatum (loan for use): A form of loan [COMMODATE] in which a device is provided to an individual or organisation *for use without transfer of ownership*, typically for a defined or renewable period, and with the obligation to return the device or allow reassignment when the agreed conditions end.

In circular device management contexts, commodatum arrangements support collective access by enabling maintenance, replacement, traceability, and reassignment of devices over time, while preserving shared stewardship and accountability.

Device: Any Internet-capable end-user or networking device, including laptops, desktops, tablets, smartphones, routers, switches, antennas, access points, and IoT equipment.

Federated inventory/registry: A network of interoperable device registries that enables transparency, accountability, cross-organisational coordination, and scaling without requiring centralisation.

Meaningful connectivity: Internet access that is not only technically available, but affordable, reliable, socially relevant, and supported by skills and agency.

A multi-dimensional concept encompassing not only technical access (infrastructure, connectivity, devices), but also social relevance, community agency, cultural and political meaningfulness, inclusive governance, and sustainable local ownership. It recognises that connectivity gains value when aligned with community practices, needs, and aspirations. [GISW2024]

This BCP focuses on community/local-scale, decentralised practices relevant to access networks, community/local facilities, and underserved contexts.

3. Problem Statement

Despite investments in access networks, many communities remain excluded from meaningful connectivity due to:

* Insufficient availability of functional end-user and network devices for households, schools, and community organisations;

* Markets dominated by non-repairable or locked-down hardware and software preventing device reuse, with short usage cycles followed by replacement;

* Limited local repair capacity, including insufficient skills, limited access to spare parts, and limited tools for diagnostics, secure data handling and refurbishment;

* Lack of interoperable systems to manage and track device lifecycle and accountability across donors, refurbishers, and recipient organisations and persons;

* Premature disposal of devices, contributing to environmental harm and e-waste;

* Organisational models that assume permanent individual ownership, which can hinder redistribution, maintenance, and re-assignment to evolving needs.

* Individual private ownership of devices, which complicates redistribution and limits scalability.

* Lack of digitalized device management/transparency tools limits trust among donors and refurbishers, obstructs environmental and social impact assessment, and prevents coordinated processing of large-volume donations.

* Network connectivity alone cannot solve digital exclusion if individuals lack adequate network and user devices.

Without collective access models and digital traceability, communities struggle to pool devices, coordinate refurbishment at scale, assess impact, or establish donor trust and accountability [Roura2025]. As a result, access networks alone are insufficient to close the digital divide.

Addressing device availability is therefore a foundational requirement for equitable, inclusive, and rights-preserving Internet access.

4. Principles for Best Current Practice

4.1. Device availability as foundational infrastructure

Device availability SHOULD be treated as a core component of Internet access, alongside network coverage, affordability, and skills.

4.2. Local capacity and digital sovereignty

Communities SHOULD be able to maintain, repair, and manage devices without exclusive dependence on external vendors or proprietary restrictions.

4.3. Collective access and commons-based governance

Where appropriate, devices SHOULD be managed, rather than private ownership, under collective access models to improve equity, reuse rates, and long-term sustainability.

4.4. Open and interoperable software tooling

Device lifecycle management SHOULD rely on open-source and interoperable software tools to support transparency in diagnostics, tracking, and refurbishment workflows, device loan, federation, and replication.

4.5. Repairability and lifecycle extension

Repair, reuse, and refunctionalization SHOULD be prioritised over recycling or disposal, as long devices can be useful.

4.6. Transparency, accountability, and traceability

Device history and quality SHOULD be digitally recorded to support accountability, donor and user trust, and impact assessment.

4.7. Privacy and security by design

Reuse workflows SHOULD embed privacy-preserving data sanitization and prevent exposure of personal data.

4.8. Environmental responsibility

Circular practices SHOULD aim to reduce e-waste and environmental harm throughout the device lifecycle.

4.9. Community-rooted governance and social relevance

Connectivity initiatives SHOULD prioritise community/local participation, co-design, and governance of infrastructure and devices, enabling communities to determine what meaningful connectivity means locally and how devices and access are aligned with livelihoods, education, and inclusion goals.

5. Best Current Practices

5.1. Digitalized Circular Device Management

Circular management systems SHOULD include:

* Unique device identification (e.g., labels/QR codes) and lifecycle records;

* Structured triage, diagnostics, and condition grading;

* Secure data sanitization steps recorded in device logs;

* Chain-of-custody tracking across donors, refurbishers, and recipient organisations and end-user persons;

* Interoperability with other inventory and infrastructure systems (e.g., ERP, network registries) where beneficial;

* Support for processing large-volume device donations or procurement across multiple refurbishers to improve throughput, quality control, and traceability;

* Optional tamper-evident or cryptographically verifiable logging mechanisms for accountability in multi-stakeholder ecosystems.

These capabilities enable transparency and coordinated reuse circuits where donors, refurbishers, community and formal local organisations, and beneficiary programmes can operate with shared visibility and responsibilities.

5.2. Repair, Training, and Capacity Building

Effective programmes SHOULD:

* Distinguish between specialised refurbishing tasks (diagnosis, repair, sanitization, refurbishment) and community-level access/ accompaniment functions;

* Provide training that combines basic hardware diagnostics and repair (electronics), locally sourced spare parts, operating system and application installation and configuration (software), and practical repair and maintenance tasks;

* Use accessible pedagogies that reduce barriers for youth, women, and marginalised populations;

* Integrate digital literacy and social inclusion objectives (education, employability, access to services);

* Provide pathways for income generation or employment (e.g., social enterprises, cooperatives, paid refurbishment);

* Use digital traceability systems to compute environmental indicators (e.g., avoided e-waste, estimated CO₂ savings) and social indicators (e.g., beneficiary counts, institutions served), reinforcing accountability for donors, policymakers, and communities.

5.3. Alignment with Access Networks and Network Devices

Device reuse SHOULD be coordinated with access-network deployments by:

* Including network equipment (routers, switches, antennas, access points) in lifecycle tracking where relevant;

* Aligning device availability with connectivity provision (so devices reach users and institutions that can connect);

* Supporting local repair and reconfiguration of networking equipment where feasible;

* Tracking performance and replacement cycles to reduce downtime and avoid stranded access infrastructure.

This document does not assume the presence of a specific access infrastructure. The practices described apply to contexts where connectivity is provided through a variety of access models, including commercial, community-driven, institutional, or any other access facilities.

5.4. Community-centred Meaningful Connectivity

Connectivity initiatives MAY:

* Engage communities in defining meaningful use for them (education, work, health, services, civic participation, cultural expression, etc.);

* Combine devices, skills development, and governance to build holistic digital ecosystems;

* Support shared facilities (community centres, libraries, schools) and collective access models where appropriate, rather than assuming all access is individual ownership;

* Design for social inclusion: enable participation of underrepresented groups (women, minorities, youth, adults), account for cultural and linguistic diversity, and empower communities to use connectivity for their own goals (education, civic engagement, small-scale enterprises, local content creation, environmental monitoring, etc.);

* Respect local agency and context, enabling adaptation of workflows and priorities over time;

* Include feedback loops and governance mechanisms to evolve deployments according to community needs.

5.5. Collective Access and Commons-Based Device Governance

Where appropriate, communities MAY treat devices as a shared digital commons. Implementations of collective access typically include:

* Assigning use-rights instead of permanent ownership to individuals or organisations;

* Allowing devices to circulate across multiple users and community spaces over time;

* Establishing clear governance rules for allocation, maintenance responsibilities, reassignment, and end-of-life decisions;

* Using open-source digital tools to track device history, condition, transfers, and responsible recycling;

* Embedding accountability mechanisms so actors (donors, refurbishers, community managers) can verify device provenance and lifecycle steps.

This model has been validated operationally in reuse ecosystems and formalised in prior research [Roura2025].

5.6. Federated Registries and Cross-community Coordination

Federated device registries MAY be used to coordinate reuse across organisations and regions while preserving local governance. Such registries can support:

* Distributed metadata sharing and device lookup;

* Cross-organisational coordination for batches and surplus devices;

* Shared accountability while avoiding centralised control;

* Federation across communities with different legal, operational, or cultural contexts.

* Multi-stakeholder governance.

Federation is essential when devices flow across regions, institutions, and countries

5.7. Secure Sanitization of Storage Media

When devices are refurbished for reuse, data sanitization SHOULD follow recognised good data sanitization practices such as ITU-T L.1081 [ITU-T-L1081]. Implementers SHOULD select and apply appropriate methods (e.g., clear, purge, or destruct) depending on media type and sensitivity, before reuse or redistribution.

Implementations SHOULD maintain documented chain-of-custody logs and sanitization records (preferably digitally linked to device lifecycle entries) to provide verifiable proof of data erasure, increase donor trust, and protect privacy.

Where feasible, refunctionalization (reuse/refurbishment) SHOULD be preferred over destruction, consistent with circular economy and environmental sustainability goals [ITU-T-L1081].

5.8. Architectural Considerations for Access Networks

The practices described in this BCP imply architectural considerations relevant to GAIA research, including:

* Device availability and repairability as part of the access architecture, not an external dependency.

* Federated registries as a decentralised control-plane component for device lifecycle management and accountability (verifiability).

* Alignment between network deployment lifecycles and device deplyment and lifecycles.

* Reduction of centralised/remote dependencies through local maintenance and governance.

These considerations may inform future research on access network architectures, operational sustainability, and resilience.

6. Human Rights Considerations

Device availability and governance affect:

* The right to access and benefit from the Internet;
* The right to repair and modify hardware;
* The right to privacy and autonomy;
* Environmental justice in communities affected by mining or e-waste.

Circular practices SHOULD mitigate risks of:

* Data leaks from improperly erased devices;
* Surveillance risks via persistent identifiers or misconfigured software;
* Exclusion due to vendor lock-in or proprietary barriers;
* Unsafe or inequitable disposal practices.

7. Security Considerations

Risks include compromised devices, malicious firmware, insufficient data erasure, unauthorised access to inventories, and forged device histories. These risks can undermine trust in reuse ecosystems and reduce access sustainability.

Risks include:

* Tampered with or compromised devices;
* Malicious firmware;
* Insufficient data erasure;
* Unauthorized access to device details in inventories and registries;
* Forged or altered device histories.

These risks can undermine trust in reuse ecosystems and shared devices, and directly reduce access sustainability.

Mitigations are RECOMMENDED, including:

* Verified testing and refurbishment workflows;
* Secure firmware reinstallation and configuration baselines;
* Cryptographic or tamper-evident logging where appropriate;
* Role-based access control for lifecycle systems;
* Periodic auditing and peer-review among participating organisations.

8. Privacy Considerations

Reuse systems SHOULD apply:

* Data minimization and least-privilege access;
* Local-first and decentralized architectures;
* Strong sanitization and verification practices;
* Transparent documentation of data handling;
* Encryption for sensitive metadata where stored or transferred.

Device identifiers SHOULD be abstracted or scoped appropriately when feasible to reduce long-term cross-context correlation risks.

9. Environmental and Sustainability Considerations

Circular device management reduces [Roura2026]:

* Demand for new hardware;
* Raw material extraction;
* CO emissions, land and water polution from manufacturing;
* e-waste in vulnerable communities, while increasing economic inclusion: build financial opportunities, increase economic independence, and create sustainable income sources.

Reuse and refurbishment (after secure sanitization) SHOULD be given priority over disposal. By enabling safe refunctionalization of devices that would otherwise be discarded, communities reduce e-waste and environmental harm, consistent with circular economy principles and L.1081 guidance that supports reconditioning over destruction [ITU-T-L1081].

10. Deployment Case Studies (Informative)

This section is informative. It illustrates how the practices in Section 5 have been applied in diverse contexts.

10.1. Catalonia and Madrid (Spain): eReuse.org Ecosystem and Social Enterprises

The eReuse.org ecosystem coordinates reuse circuits that connect donors (public and private organisations), social refurbishers, recyclers, community organisations, and beneficiaries [EREUSE]. Typical operational characteristics include:

* Intake of unused devices through institutional donation channels;
* Structured diagnostics, refurbishment, and grading by social enterprises;
* Digital lifecycle traceability through open-source inventory tooling, supporting transparency and accountability;
* Allocation of refurbished devices to individuals and organisations through models that may include subsidised pricing, sponsorship, and collective access arrangements;
* Measurement approaches that support reporting of environmental and social outcomes (e.g., devices reused, avoided e-waste, beneficiary reach).

eReuse deployments also experiment with collective access and ownership: devices may remain part of a shared pool and be redistributed as needs evolve, rather than being permanently assigned to individuals, increasing reuse cycles and long-term availability [Roura2025].

10.2. La Plata (Argentina): EKOA/UNLP Programmes

EKOA at the National University of La Plata (UNLP) operates university-linked initiatives that integrate refurbishment, training, and outreach [EKOA-UNLP]. EKOA manages its own production plant for refurbished technological equipment. Observed characteristics include:

* Involves students, faculty, non-teaching staff, researchers, and extension practitioners linked to university ecosystems, who perform activities within and outside the e-waste management and refurbishment plant, including diagnostics, repair, refunctionalization, and data sanitization.

* Refurbished devices are distributed to schools at all levels, community kitchens and food distribution centres, NGOs, hospitals, health centres, fire brigades, social organisations, university students, Indigenous communities, migrants, older adults, and other vulnerable communities. Devices are typically delivered under loan-for-use (commodate) or chain-of-custody arrangements.

* The plant serves as a reception and training site for students from technical secondary schools and university students, who engage in training activities, work-based learning experiences, and degree projects.

* The plant is also a training space for cooperatives of urban recyclers, empowering youth and adults with practical skills across the device and WEEE management chain.

* Training activities are organised with equitable participation across genders.

* Environmental responsibility is integrated through secure channels across the WEEE management chain and promoted to donors and beneficiaries of refunctionalized devices.

* Device reuse is generally linked to digital literacy programmes and territorial initiatives that provide benefits to the wider community (e.g., hospitals, fire brigades, public services).

* The initiative includes environmental education projects aimed at primary and secondary schools.

10.3. Hahatay (Senegal): Device Availability and Inclusion in Rural and Peri-urban Contexts

The Hahatay initiative addresses device scarcity in rural and peri-urban contexts where new hardware can be unaffordable or unavailable [HAHATAY]. Observed characteristics include:

* Sourcing and reusing devices as a practical prerequisite to meaningful connectivity;

* Integration with community programmes that support digital literacy and community benefit;

* Emphasis on locally appropriate maintenance and operational continuity.

These contexts highlight the importance of aligning access-network plans with device availability and repair capacity to avoid stranded infrastructure.

10.4. Rosario (Argentina): TAU/RAEE and Territorial Programmes in the Villas

TAU/RAEE operates a community-embedded ecosystem in and around Rosario [TAU-RAEE]. A specialised cooperative (TAU) carries out the technical processes of diagnostics, repair, data sanitization, refurbishment, and e-waste management, while community centres and territorial programmes focus on access, accompaniment, and local participation.

Observed characteristics include:

* A cooperative of young workers (TAU) manages the e-waste and refurbishment plant where diagnostics, repair, and data sanitization are carried out.

* Community centers do not perform the technical refurbishment themselves, but act as access and coordination points.

* Training programs empower youth and adults with practical skills.

* Refurbished devices are redistributed to schools, families, cooperatives, and social organizations, generally under cession-of-use schemes rather than as permanent donations, including maintenance and replacement, to preserve traceability.

* Inclusive pedagogical approaches prioritize women and underrepresented groups.

* Environmental responsibility is integrated through safe recycling channels.

* Device reuse is connected to digital literacy programmes.

These community-driven refurbishing and connectivity efforts embody community-centred meaningful connectivity: devices and networks are locally governed, refurbishment and reuse are collective, and infrastructure is shaped by community needs and practices, not by vendor-driven or top-down deployment. [GISW2024]

This model demonstrates how circular device management can be sustainably embedded in informal settlements and marginalized communities.

This case illustrates a division of labour model that can be replicated: specialised refurbishers/cooperatives ensure technical integrity and sanitization, while community organisations ensure access, inclusion, and community-centred governance.

11. Replication Guidelines

Organisations seeking to replicate these practices SHOULD consider:

* Establishing partnerships among donors, specialised refurbishers, community organisations, and (where relevant) access-network operators;

* Deploying open-source, interoperable inventory tooling to enable traceability and accountability;

* Developing training pathways (diagnostics, software installation/ configuration, repair, sanitization, responsible e-waste handling);

* Selecting appropriate governance models, including collective access where it improves equity and sustainability;

* Aligning device availability with connectivity provision and local access conditions;

* Defining privacy and security controls, including sanitization verification and role-based access to inventories;

* Establishing impact reporting for environmental and social outcomes to maintain trust and continuous improvement;

* Comply with WEEE management and re-functionalisation regulations.

12. IANA Considerations

This document has no IANA actions.

13. Acknowledgements

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